

METHODOLOGY FOR  
DETERMINING AND ALLOCATING  
CARRYING CAPACITY  
IN A ROADED NATURAL  
RIVER CORRIDOR

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## ABSTRACT

The Cache La Poudre River, located on the Arapaho - Roosevelt National Forest, recently received Wild and Scenic River designation. Included were two "wild" segments and a 38 mile recreational segment. The recreational segment of the river canyon has long been an outstanding attraction on the Estes-Poudre Ranger District. Easily accessed by a State Highway, Poudre Canyon is popular with motorists viewing scenery, campers, picnickers, anglers, and whitewater rafters. The recent Wild and Scenic River legislation for the Poudre Canyon required a management plan for the river be completed within 3 years. A key element of the management plan is the determination and allocation of the Carrying Capacity for the various recreation opportunities. The Recreation Opportunity Spectrum (ROS) class for the corridor is mostly Roded Natural. This is a designation which provides very few guidelines for determination of carrying capacity and therefore allows great flexibility in the determination. In order to make land management decisions for this area, it was necessary to develop a methodology for determination and allocation of the carrying capacity for the Poudre Canyon river corridor. The methodology developed suggests that standards for social carrying capacity should be determined by sampling user preferences and integrating the results with manager's preferences.

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## EXECUTIVE SUMMARY

Title      Methodology for Determining and Allocating Carrying Capacity  
              in a Roaded Natural River Corridor

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### Summary

The objective of the research project was to develop a methodology for determination and allocation of the recreation carrying capacity in the Cache La Poudre River Canyon. Originally it was assumed that allocation could be achieved by devising some method for dividing up the theoretical area capacity which had been calculated using the procedure contained in the Arapaho - Roosevelt National Forest Land and Resource Management Plan. That procedure is to multiply the number of acres of a particular vegetative type by the standard for that Recreation Opportunity Spectrum (ROS) class and adjust it according to useable acres, historic use patterns etc. This is based on direction provided in the ROS Book. Although this process has worked fairly well in wilderness and non-motorized areas, there are few standards and guidelines which can be applied to this mostly Roaded Natural corridor. It is difficult to apply this same process in the Poudre Canyon because the standard (coefficient) for Roaded Natural applies only to dispersed recreation. This could not be used to calculate an overall area capacity which would also include developed sites and river use. It became clear that a methodology for determination was needed in addition to allocation.

The ROS Book described another method for determination of carrying capacity. That procedure was to inventory all recreation activities, inventory use, and determine capacity based on that information. This approach was used since the "standard procedure" did not seem applicable to the situation in the Poudre Canyon corridor. The corridor was divided into segments or subsets of Roaded Natural so that the inventoried information could be managed effectively. The inventoried information was displayed on clear mylar overlays. A review of the literature suggested that 4 types of carrying capacity needed to be examined. These 4 are: ecological - concerned with impacts on the eco-system; physical - which is concerned with the amount of space; facility - refers to improvements intended to handle visitor needs; and social capacity which involves impacts which alter or degrade human experiences. Each of these has a theoretical maximum and a practical maximum. The theoretical maximum, a measure of maximum potential supply, is based on each acre of the Forest being at its upper physical and/or social capacity limit by ROS class. These values are useful as a starting point for land management planning decisions. The practical maximum takes into account such things as useable vs. unusable acres, weekend vs. weekday use and occupancy rate.

Often, one of the four types of carrying capacity becomes a limiting factor in land management planning decisions. For example, if the resource is being degraded by human activities (ecological), this could suggest prohibition or limitation of those activities. If social capacity is the limiting factor in a Roaded Natural area, then a standard must be determined. Review of the literature revealed little information on standards for numbers of persons on whitewater rafting rivers in Roaded Natural corridors. The literature suggests that it would be difficult to determine a standard for social capacity by ROS class experience because user preference is not directly correlated with the type of recreation experience being offered. The implication is that user preference should be ascertained on a case by case basis. The methodology developed here suggests that sampling of user preference should include commercial and private users of the river, clients of the commercial users, out of town visitors, local residents, residents of Ft. Collins and a variety of organized user groups. Manager's experience, the user preference survey and the data collected on current use would be used in the development of the social carrying capacity for each segment. The carrying capacity would be expressed as a range of PAOT for each segment and each activity. This range would be similar to defining the Limits of Acceptable Change for a wilderness area. Monitoring the annual use would be included.

A summary of the methodology is as follows:

1. Inventory and map the current situation: location of all the recreation activities, physical characteristics, land ownership, etc.
2. Arrange the information collected in logical subdivisions. Describe the primary emphasis of each.
3. Describe the four types of carrying capacity - both theoretical and practical maximum.
4. Determine the limiting factor or factors. If social, obtain user preference, and manager preference information.
5. Determine and allocate the carrying capacity for each segment. Define the limits of acceptable change.
6. Describe monitoring procedures.

After testing the model, I concluded that the methodology described above was a logical and easily applied procedure. It is directly related to the ROS system and the Forest Plan. The methodology provides direction for on the ground application of the Roaded Natural class in a recreational river corridor.



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CHAPTER I

INTRODUCTION

The objective of the research project was to develop a methodology for determination and allocation of the recreation carrying capacity in the Cache La Poudre River canyon. The Cache La Poudre River canyon about 10 miles northwest of Fort Collins, Colorado has long been a popular recreation corridor (please refer to Location Map). Colorado State Highway 14 runs for about 50 miles along the river beginning at the junction of Highway 287 until the Poudre river turns south where it is known as the Big South in the Comanche Peak wilderness. The canyon is easily accessible from Fort Collins, a city with a population of about 80,000, and is about one and a half hours' drive from the Denver metropolitan area. Camping, picnicing, fishing and viewing scenery have been popular with the public for the past 40 years. Forest Service facilities include 132 camping units and 35 picnic sites along the river. In addition - there are numerous pull-offs along the highway for fisherman parking and dispersed day and overnight use. In the last 10 years, use of the river by watercraft (rubber rafts, kayaks, tubes) for day trips has increased. Both commercial and private individuals use the river for rafting, and about 70% of use is commercial. The stretches of river useable and attractive to rafting do not have constructed put-in and take-out facilities except for an area outside the National Forest Boundary which was built by the State Division of Parks and Recreation. Recently the Cache La Poudre River was designated a Wild and Scenic River and it is expected that this will result in an increase in use.

One of the responsibilities of the Forest Service as a result of this legislation is to prepare a Wild and Scenic River management plan. Concurrently the district is preparing to implement the Forest Plan in the main stem of the Cache La Poudre River (please refer to the Poudre Canyon Analysis Area map).

One of the critical issues which both areas have in common is the determination and allocation of the carrying capacity in the recreational river corridor. Carrying capacity is significant in this area because of issues such as future facilities, use limits, quality of experience in the Wild and Scenic River corridor and commercial vs. private use of the river. The Recreation Opportunity Spectrum inventory determined that most of the highway/river corridor is Roaded Natural. Information on carrying capacity determination for a Roaded Natural area is fairly broad in nature. There is no detailed methodology for determining and allocating carrying capacity.

Statement of the Problem

Currently no new outfitter-guide permits can be issued on the Arapaho and Roosevelt National Forest until allocation of the recreation carrying capacity

# ROCKY MOUNTAIN REGION





has been completed. In addition, it is clear that the future will bring greater conflict among various uses as visitors compete for the same space. At this time, there is no clear procedure for determining and allocating recreation carrying capacity in a Roaded Natural river corridor.

#### Hypothesis

The hypothesis is that an effective way of determining capacity in the Poudre Canyon corridor area would be to segment the corridor into "areas" of like recreation opportunities or like physical characteristics or like current uses. Then separate capacities could be determined for each area. The expected result is a methodology for determining carrying capacity for each segment of the Roaded Natural area. Before final establishment, carrying capacity for all segments would be summed and the total area carrying capacity would be evaluated. The carrying capacity would be expressed as a range of PAOT and this range would define the limits of acceptable change for each activity in each segment.

#### Delimitations (parameters)

This paper is not an Area Implementation Program or a management plan. This paper will not attempt to modify or create procedures which are already established for determination of such things as soil condition by Frissell class, water quality, developed facility capacity. This paper will not establish management objectives. Those broad objectives already established in the Forest Plan will be used as guidance during allocation. The procedure described here is pertinent to other than Wild and Scenic rivers.

#### Definitions

carrying capacity - the level of use beyond which impacts exceed acceptable levels specified by evaluative standards.

ecological carrying capacity - concerned with impacts on the eco-system.

physical carrying capacity - concerned with amount of actual space.

facility carrying capacity - refers to improvements intended to handle visitor needs.

social carrying capacity - refers to impacts which impair or alter human experiences.

NOTE: The preceding five definitions were taken from Shelby and Heberlein's book, Carrying Capacity in Recreation Settings.

theoretical maximum capacity - the maximum number of persons at one time which can safely be accommodated. This is one of the first steps in determination of carrying capacity.

practical maximum capacity - the maximum number of persons at one time which can be comfortably accommodated. For purposes of this paper, it was arbitrarily calculated to be 2/3 of the theoretical maximum carrying capacity.

Frissell class - A system for classifying condition of campsites using visual criteria.

#### Basic Assumptions

Methodology will meet Forest Land Use Plan and National Environmental Policy Act (NEPA) requirements.

The coefficient given in the Arapaho and Roosevelt Forest Plan for dispersed recreation in the Roaded Natural ROS class was not intended to be used to calculate an overall area carrying capacity. This is based on personal conversation with one of the authors of the ROS Book, Chuck McConnell. No standards for social carrying capacity have been established for a Roaded Natural area which includes boating, fishing, camping, motorized use and picnicing.

#### Limitations

Estimates of use were used to test the model. This paper does not discuss balancing conflicts between uses because the research did not uncover any conflicts. It is suggested that sampling of user preference will provide guidance on this point. Sampling of user preferences was not accomplished as part of this field project. This could be the focus of another research project.



## CHAPTER II

### REVIEW OF LITERATURE

A significant number of research papers written in the last 30 years have been devoted to some aspect of carrying capacity. A large number have been written about wilderness carrying capacity and relatively few concerning Roaded Natural areas. In addition, much of the work has attempted to define carrying capacity or has focused on the need to establish carrying capacity. Not much has been written on methods to actually establish carrying capacity numbers especially for the social aspect. The unique situation for the Poudre Canyon is the easy accessibility and wide diversity of available recreation opportunities: boating, fishing, camping picnicing and viewing scenery - all in a recreational Wild and Scenic River corridor. Review of the literature included the following topics: river management, Wild and Scenic River management, determination of carrying capacity and allocation of carrying capacity.

#### Wild and Scenic River Management

Wild and Scenic River management was not explored in great depth - the majority of the papers reviewed dealt with restrictions in wild sections of Wild and Scenic Rivers and were not applicable to this problem. Five management plans for recreational segments of Wild and Scenic Rivers were reviewed. These included the Flathead, the Salmon (Main Fork), the Chatooga, the Au Sable and the Marquette rivers. None of these plans include a situation with a highway paralleling the river or any other factor which results in easy access at numerous points along the road as does the Poudre Canyon. These plans for recreational segments did not provide applicable information on social standards for carrying capacity because some other factor was already limiting.

#### River Management

River management research looked promising initially but proved to be of limited use. One study tested the premise of different ROS classes having different recreation experience opportunities Wollmuth et. al. (1985). The researchers found no difference between a Roaded Natural and a Rural section of the Arkansas river in Colorado. Westenburg and Jubenville (1983) developed a decision making model for the management of the Kenai River in Alaska - one of the most heavily used in Alaska. The model may be useful to the implementation of the Forest Plan for the Poudre Canyon area. One of the key elements in their study was this: managerial options were identified and the response to these options of various subgroups was measured by using a mail questionnaire.

Most of the river management research focused on wilderness and primitive settings and overnight use, while the Cache La Poudre River is primarily a day use river for boaters paralleled by a State Highway. In wilderness and primitive settings, the limiting factor was usually an ecological or physical factor. For example, the condition of the campsites (ecological) might be such that use was prohibited or limited. Or the finite number of campsites

(physical) limited amount of use. These factors may be more limiting than social capacity, but would result in limiting numbers of people. In addition, most of these river situations had limited launch facilities and access points.

Telephone interviews with river managers in February 1988 provided additional information. River use has been restricted on the North Platte river for the past 9 years.<sup>1/</sup> The Northgate Canyon river management plan completed in 1985 uses the carrying capacity standard in the wilderness prescription from the Forest Plan. Controlling use on the river is fairly easy since there is only one launch facility.

Other interviews with managers of rivers in Roaded Natural settings revealed that many of them do not have limitations on those entering or using the river. The Colorado River in Glenwood Canyon, which is paralleled by Interstate 70, does have restrictions on use.<sup>2/</sup> This stretch has only one launch facility and the use is 95% commercial outfitters. They are permitted to enter the river at 10 minute intervals. This limit is based on safety factors. The Dolores River near Durango, Colorado does not currently limit use on this Roaded Natural stretch but current planning includes consideration of use limitations.<sup>3/</sup> The Daly stretch of the Colorado River out of Moab, Utah, another non-wilderness setting does not have any restrictions. Managers are offering a variety of river recreation opportunities and this is one of the unrestricted ones.<sup>4/</sup> The Rouge River in Oregon is one of the most studied rivers. Managed out of Medford, Oregon, the wild segments of the Rouge include limitations on use and these were largely determined by the finite number of campsites along the river.<sup>5/</sup> There is a recreational stretch of this Wild and Scenic rivers but no restrictions are in effect at this time.

#### Determination of Carrying Capacity

Determination of carrying capacity has been researched and written about extensively. Some of the literature now advocates discussing the carrying capacity in terms of four distinct types Shelby and Heberlein (1986). These four are: ecological which is concerned with impacts on the eco-system; physical which is concerned with the amount of space; facility capacity refers to improvements intended to handle visitor needs; and social capacity which involves impacts which alter or degrade human experiences. Although much has been written specifically about ecological carrying capacity, most of the literature agrees that social carrying capacity presents the most difficulty for the manager because of the human element. van Wagtendonk (1985) determined ecological capacity in Yosemite National Park. Protection of the environment was critical, therefore ecological standards became the limiting factor. Another paper on whitewater rafting in West Virginia used statutory legislation and safety as the limiting factor Boteler (1985).

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- 1/ Hoshide, Gary. Feb. 1988. USFS: R2, Routt NF, North Park RD, Walden, CO.
  - 2/ Johnson, Bill. Feb. 1988. USFS: R2, White River NF, Eagle RD, Eagle, CO.
  - 3/ Christianson, Tom. Feb. 1988. BLM: San Juan Resource Area, Durango, CO.
  - 4/ Christiansen, Pete. Feb. 1988. BLM: Grand Resource Area, Moab, Utah.
  - 5/ Leffmann, Jim. Feb. 1988. BLM: Medford District, Medford, OR.



### Allocation of Carrying Capacity

Review of the literature on allocation of carrying capacity yielded a number of papers on allocation between outfitted and non-outfitted publics which were compiled by Leon J. Buist in Recreation Use Allocation: Proceedings of a National Conference in 1981. None contained a methodology for determination and allocation of carrying capacity in Roaded Natural areas, but some useful information surfaced. Shelby (1981) states that there is public support for reasonable restrictions. Lime (1981) maintains that allocation needs to be considered on a case by case basis for each individual river or region. McCool and Utter (1981) developed 8 criteria useful in evaluating recreation use allotment but assumes that you have an "established use limit". Cordell (1981) and Cullen (1985) contended that pricing should be considered as a way to allocate use. Shelby and Heberlein (1986) also suggest 5 strategies for allocation: pricing, queuing (first-come/first-served), merit, reservation and lotteries.

When ecological, facility and physical capacities are not limiting factors, a number of researchers suggest that user preferences be assessed in order to determine social carrying capacity Shelby and Heberlein (1986). Driver, Brown, Stankey and Gregorie (1987) recently wrote an assessment of the ROS system using the Forest Service as an example of on the ground application. Although overall they felt that the design of ROS is solid, they suggested several aspects of the ROS system that need further research. One of those needs is information on user preference. Shelby and Heberlein (1986) make a strong case for determining user preference before limiting social capacity. They maintain that there are two components to carrying capacity: the descriptive and the evaluative. The descriptive component concerns what is happening. The evaluative describes what should be happening. The evaluative component is more difficult to deal with because it involves value judgement about the type of experiences and how those are valued. It also assumes that management objectives are established. Often management objectives are established but they are too broad to be of value in determining carrying capacity. Shelby and Heberlein also discuss the minimum, the maximum and the optimal carrying capacities. This breakdown is similar to the concept described in the Forest Service ROS Book regarding theoretical maximum and practical maximum. This paper focuses on practical maximum or optimal carrying capacity, although a brief discussion of theoretical maximum will be included for clarity.

Shelby and Heberlein maintain that the best approach to determining evaluative standards is to measure individual user preferences and allow a shared norm or group standard to emerge from the user responses. They maintain that the two other models for obtaining evaluative standards, satisfaction and perceived crowding, are less useful than one based on user preferences. Their contention is based on the fact that research does not support the assumption that increase in use is directly related to decrease in user satisfaction. Perceived crowding is one aspect of user preferences. In non-wilderness settings, use levels or encounters do not have as great an effect on perceived crowding as a number of other social psychological factors which are beyond managers' control.



## Arapaho-Roosevelt National Forest Land Management Plan and the ROS Book

For Roaded Natural, the Recreation Opportunity Spectrum (ROS) Book describes the setting, expected experience, and expected activities but does not detail how many encounters are expected or numbers of persons at one time (PAOT). There is a standard for number of PAOT / acre for dispersed recreation in a Roaded Natural area. The "standard" way of determining carrying capacity in Region 2 is a variation of that shown in Chapter 24 of the ROS Book. Each situation is taken on a case by case basis but the basic starting point is this: for each management prescription area, calculate the number of persons at one time for a given ROS class by multiplying the number of acres of a given vegetation type times the given factor. The result will be a theoretical number in PAOT for carrying capacity. That number is then refined by adjusting for useable acres, historic use patterns and general attractiveness of the specific ROS class for the area in question. The area in question could be rather large (20,000 acres) or relatively small (750 acres). The level of detail would be determined by the issues and concerns uncovered during the scoping process. When the overall area capacity is being determined, other standards in the Forest Plan are taken into account. Many prescriptions in the Forest Plan contain standards for the expected number of encounters, number of PAOT/per mile of trail, number of campsites allowed along lakeshores (dependent on size), number of campsites/per mile of trail. The Roaded Natural/potential Wild and Scenic River prescription does not. The Forest Plan designated existing and potential developed recreation sites a separate management prescription area with a separate carrying capacity. The ROS Book does not give much direction as to how the capacity in developed sites should fit into the overall Roaded Natural capacity. Neither does the Forest Plan. In fact, quite a bit of flexibility for management exists in the Roaded Natural class.

Chapter 25 of the ROS Book suggests that another approach is to derive capacity directly in RVD's by considering the specific activity mixes occurring on the Forest and summing the individual activity capacities to obtain one total maximum capacity. Again this approach doesn't provide any limitations for amount of developed facilities or numbers of expected encounters. For an area of 32,000 acres with a 57 mile state highway corridor, a river designated Wild and Scenic, and potential for conflict among limited recreation opportunities, more direction is needed for analysis of land management questions. Should additional campgrounds and picnic areas be constructed? If so how large and at what locations? Should the primary use of some sections be devoted to boating activities? Should put-in, take out and boat chute facilities be constructed? How will this affect fishing in the "most fished river in the state"? How much of the carrying capacity should be allocated to what activities? What IS the carrying capacity?

The method for determining carrying capacity is broadly outlined in the ROS Book and that method is almost identical to that referred to in the Arapaho and ground application in a Roaded Natural area. What is not found in these two



Roosevelt National Forest Land Use Plan. These two sources provide a beginning by specifying the theoretical maximum but do not provide a procedure for on the publications are four elements crucial to determining and allocating carrying capacity in the Poudre Canyon corridor; 1) methods for fine tuning the actual carrying capacity determination; 2) methods for on the ground application; 3) guidelines for how to fit developed sites into a Roaded Natural area; 4) standards for social carrying capacity. It should be noted that Roaded Natural in the ROS system was specifically designed so that it includes maximum flexibility for managers.1/

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1/ McConnell, Chuck. USFS: R10, Juneau, AK. Telephone conversation in Feb. 1988.

## CHAPTER III

### PROCEDURES

As stated earlier, there is no established methodology for determining carrying capacity which applies to the unique situation in the Poudre Canyon corridor. The wide variety of recreation activities which includes boating, picnicing, camping, fishing, and viewing scenery from a State Highway creates a complex situation for determining and allocating area carrying capacity. In addition there are no guidelines for numbers of encounters, number of parties and no mention of river capacities. Neither are there guidelines for how to fit the river capacity into the area capacity. In short there is no methodology for how to determine and allocate the various recreation activities in a Roaded Natural area.

The ROS Book lists two methods for determination of carrying capacity. One of these is to derive capacity directly from RVD's by considering the specific activity mixes occurring on the Forest and calculating an area capacity. Though this procedure was designed to be used at the Forest or Regional level, part of the process can be applied to this problem as a starting point.

A logical procedure to arrive at the objective - a methodology for determining and allocating the carrying capacity in Poudre Canyon Management area involves the following steps:

1. Inventory and map the current situation. This includes mapping the recreational facilities, recreational activities, physical characteristics, and the landownership. Mapping includes potential locations for recreational activities and/or facilities. The inventory includes the current use, and the current condition.
2. Arrange the data in meaningful subdivisions for analysis. This could result in several subdivisions of the Roaded Natural ROS class. A description of the primary emphasis for each segment is included. Segments can be based on geographic or topographic features, recreational activities or land ownership.
3. Describe the four types of carrying capacity for each segment. The foundation for carrying capacity will be current and future activities. Define the theoretical maximum and the practical maximum for each.
4. Determine the limiting factor or factors. If social, obtain user preference, and manager preference information. The limiting factor could be an ecological factor, physical space, or facilities. When none of these emerge as the limiting factor, social carrying capacity will need to have a standard developed. It will likely be based on a mix of user preference and professional experience. This includes decisions about future developed facilities. Sampling of user preference can be obtained in a number of ways.

NOTE: If current use reveals conflicts among recreation activities, sample user preference on different alternatives for resolving conflicts.



5. Determine and allocate the carrying capacity for each segment. The end product will be expressed as a range of numbers of PAOT for each area or segment. Limits of acceptable change are clearly defined. If appropriate, recommendations for action will be included when use levels are near the high end of the range or if environmental resource standards are being exceeded.
6. Describe monitoring procedures. These should be designed so that managers are able to predict when use levels are approaching numbers which will change the recreation opportunity experience from that established as the management objective for the area.

The methodology outlined above was refined after actually going through the first five steps with an example (inventory through determination and allocation) for one segment. Testing the model in this manner identified minor problems with the procedure which were corrected. It was also a test of the hypothesis. The scope of this paper was necessarily limited by the time frame imposed on the research project. It was not meant to be a decision document or management area plan. The objective was to outline a logical procedure to arrive at carrying capacity for a Roaded Natural river canyon and provide guidance for allocation decisions. The contribution is providing a procedure which can be applied to other Roaded Natural corridors, particularly those that include rivers and to recreational segments of Wild and Scenic rivers. A more detailed discussion of testing the procedure is found in the Appendix.

## CHAPTER IV

### ANALYSIS OF DATA

Overall findings suggest that the steps outlined in Chapter III comprise a logical method for determining and allocating carrying capacity for a Roaded Natural river corridor. The methodology combines portions of existing procedures but adds more detail and suggests new procedures which provide guidance for on the ground application. In addition, the methodology identifies missing data and the procedures for obtaining missing data.

The inventory and mapping described in Chapter III was carried through for most of the Poudre Canyon corridor using both existing data and data obtained during the course of the research project. Suggested boundaries for segments were determined and are briefly described below as an example. One segment was selected as an example to complete all the steps through step 5 - allocation. (Where data was missing, an educated estimate was used.) The information below is included to help describe the analysis of data.

Example of Step 2: The following is an example of appropriate subdivisions . (Step 2) for the Poudre Canyon corridor. Please refer to the attached map. .

Poudre Park AREA 1 - Boating/Private Land (6.5 miles)

From FS boundary in Sec. 4 Township 8 North, Range 70 West to the west side of the village of Poudre Park (SE 1/4 Sec. 2 Township 8 North, Range 70 West). This section is about 80% private land but is currently the most popular stretch for boating. Greyrock Trailhead is also located here.

Mishawaka AREA 2 - Boating/FS land, Moderate to Heavy Use Developed Facilities (8 miles)

From Poudre Park to Steven's Gulch Campground. This section is also used for boating, contains 1 fee CG (19 units), and 6 non-fee developed facilities (33 units).

Dutch George AREA 3 - Outstanding Visuals/Dispersed Camping (4.5 miles)

From Steven's Gulch up to and including the confluence of the Little South. This area includes the Big Narrows section which is undeveloped as well as an area popular with owners of large outdoor recreation vehicles for dispersed camping.

Mountain Park/Kelly Flats AREA 4 - Heavy Use Developed Facilities (8 miles)

From confluence of Little South to Pingree Park Rd. This area contains the most popular developed sites, 2 major fee campgrounds containing 68 camping units, 9 picnic units and a group picnic area accommodating 200. There is also a trailhead facility for the Mt. McConnel/Kreutzer National Recreation trail.



Pingree/Rustic AREA 5 - Low to Moderate Use Developed Facilities (4 miles)  
From Pingree Park Rd. to Rustic. This area begins the cutoff point where motorized use and picnicing drops off. Area contains two developed facilities which only have one unit each. Both have the capability to accommodate additional units.

Rustic AREA 6 - Private Land Ownership (3 miles)  
From Rustic to Arrowhead Lodge. This section is almost exclusively private land.

Arrowhead/Big South AREA 7 - Private Development/State land/Developed Facilities (14 miles)

From Arrowhead Lodge up to and including Big South trailhead. This area includes about 9 miles of non-federal land, two trailheads, two small fee campgrounds (24 units), and recently acquired NFS lands with buildings.

Cameron Pass AREA 8 - Winter Sports/Non-urban Developed Facilities (9 miles)  
From Big South trailhead to Cameron Pass. This area accesses three major reservoirs, several developed facilities and two trailheads. In addition, it includes the junctions of the Longdraw Road and the Laramie River Road. Winter sports are very popular in this area.

## TESTING THE MODEL

I chose Mishawaka Area 2 to run through the procedures and test the model. Mishawaka is the Steven's Gulch to Poudre Park stretch which is 8 miles long. Most necessary data was available. Where it was not, I used the best estimates possible.<sup>1/</sup>

For example, in the social carrying capacity segment on page 18, no sampling of user preference was carried out. Therefore the data in that section is purely as an example.

Step 1 Inventory and Map the Current Situation - This includes physical features, recreation activities and current use.

<u>INVENTORY</u>				<u>USE %</u>		
<u>Recreation Sites</u>		<u>PAOT</u>		<u>wkend</u>	<u>wkdy</u>	<u>weighted average</u>
Steven's Gulch	CG	5 units	15	100	56	84
Upper Landing	CG	5 units	15	48	10	22
Stove Prairie	CG	8 units	24	94	33	52
Ansel Watrous	CG (fee)	19 units	57	96	68	77
Mishawaka	CG	1 units	3	100	40	59
Mishawaka potential	PG	5 units	15			
Diamond Rock	PG	7 units	21	84	40	54
Poudre Park	PG	2 units	6	95	50	64

Young's Gulch -potential 15 unit PG combination 25 unit Trailhead.  
Current use of this site is for a popular unofficial shooting range.

Dispersed Recreation: Nineteen roadside pull-offs used for a variety of dispersed uses. Three of 19 are used for overnight camping. Sixteen of 19 are for day use: playing in river, fishing, picnicing etc. Use is discussed under Highway Department traffic volumes.

Wildlife/Fishing Activities: This section of river is entirely artificially stocked. There is one site for a potential interpretative (sheep viewing) site. Three of 19 roadside pull-offs are popular fishing spots. There is one additional popular fishing spot below Ansel Watrous.

### \* Estimate of Use

Approximately 15 anglers/mile per day during the fishing season.

NOTE: Good data was available for a stocked section from Mountain Park Campground to Pingree Park Road. After extrapolation from a 1983-84 study, use was determined to be 23 anglers/mile per day. The sample period was from July 21, 1983, to October 16, 1983, 24 weekdays and 25 weekend days. The same study indicated that the wild section just below Area 2 was 11.8

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<sup>1/</sup> An asterisk (\*) indicates the estimates that were used.



anglers/mile. Since one cannot directly extrapolate (the Mountain Park section is heavily fished because of the two popular campgrounds), 15 anglers per mile stream per day was used.

Boating Activities: Boating season is approximately May 15 thru August 15. The best days are June through July. No overnight use occurs - most trips only take 2-3 hours and the longest are about 6-8 hours. Since boaters are always within a 1/4 mile of the State highway, overnight use is not very attractive.

This segment includes two stretches of river which are commonly run by rafters. The Upper Mishawaka run - 4 miles long. Put-in is Steven's Gulch CG, Take-out is Poudre Park PG. (There are a couple other put-in places used by some rafters.) Potential put-in is about a mile below Steven's Gulch at Stove Prairie CG. The Lower Mishawaka run is 2 miles long. Put-in is on private land (no public ROW) at Mishawaka Inn, take-out is around Poudre Park PG. A potential lunch spot for commercial users is located below Mishawaka CG.

\* Estimate of Use from May 15 through August 15

Commercial use is a group of five rafts (eight persons each). Private use is either two rafts (five persons each) or two kayaks.

Weekday use (commercial and private): Three out of five weekdays, there are two launches per day. Weekend use - Commercial use includes about four launches each on Saturday and Sunday (rafts only). Private use includes about eight launches each on Saturday and Sunday (rafts & kayaks).

Visuals Resources: This area includes one of the more outstanding sections of scenery in Poudre canyon. The characteristic landscape includes mostly Variety class A (distinctive). This is largely due to the presence of the river but also because of the section of steep canyon walls above Mishawaka. The sensitivity Level is 1, the highest, since public concern for scenic quality is high. The adopted visual quality objectives includes both retention and partial retention.

Land Status: Most of this segment is National Forest System lands with the exception of two 40 acre tracts in private ownership at the Mishawaka Inn. Special Uses include one summer home group at Poudre park with 9 cabins, one additional cabin and one spring development.

Highway Department Average Daily Traffic (ADT) volumes and Roadside Parking: Stove Prairie Rd. intersects this segment about 1 1/2 miles below Steven's Gulch.

\* Estimate of Use

The average daily traffic volume for the stretch of road from the National Forest System (NFS) boundary to Eggar's is 1600 cars per/day. That's about 23 miles of road or 70 cars/mile per day. This is an average over the entire year. There are 19 roadside pull-offs on FS land which can accommodate approximately 56 cars. There is 1 pull-off on private land (Mishawaka Inn) that can fit about 4 cars. About 75 % of these pull-offs are fully occupied on summer weekends. About 30% are occupied during the week.

Step 2 - Arrange the Data in Meaningful Subdivisions and describe the primary emphasis - Step 2 has been shown as a hypothetical example at the beginning of this chapter.

Description of Area: The area is almost entirely National Forest System lands. It contains a relatively heavy proportion of developed sites - although the current designation of 38 campground units and 14 picnic units may not be the most efficient use of potential and existing sites. The upper landing campground, which is not showing a very high occupancy rate, is one which is relatively hidden from the highway. Almost the entire section is used as one of the rafting runs commonly recognized by Outfitters and Guides and private users. It's the second or third most popular of five runs. It contains an outstanding section of scenery. It has a relatively high proportion of pull-offs. Roadside pull-offs are fairly evenly distributed. There are no developed Put-in or Take-out facilities. The section has three primary uses: camping, boating and picnicing. A decision needs to be made about Young's Gulch. There is an opportunity to provide a trailhead for a lower elevation trail (already existing). Currently the safety of vehicles and visitors is in jeopardy because a large borrow pit area in the parking lot is commonly used for target shooting practice. Some users have expressed the desire to see additional picnic sites added - or some of the smaller campgrounds converted to picnic grounds. No archeological sites were found.

Possibilities for management parameters include regulating the number of parking spaces, the number of developed sites, the number and location of put-in and take-out sites, the number and timing of launches, where camping takes place. It would be difficult to regulate the number of motorists, the number of fishermen and dispersed day use. Nor is there any indication that there is a need to regulate these activities.

Step 3 is to describe the four types of carrying capacity: Both the theoretical maximum and the practical maximum. (Step 4 - determine the limiting factor is also included here.) The practical maximum is arbitrarily set at 2/3 of the theoretical maximum.

#### Ecological Carrying Capacity

##### \* Estimates

6 dispersed campsites are in Frissel Class 4; need to be closed & rehabilitated. Eight dispersed campsites are in Frissel Class 3; need to be monitored. Five developed site units need to be properly hardened. Two sections of streambank need to be rehabilitated where the river is undercutting the bank. Overall, ecological is not a limiting factor.

Physical Carrying Capacity: Theoretical maximum for boating is 660 watercrafts at one time. This includes both rafts and kayaks and is based on physical space (8 miles) and the safety factor of three - four boatlengths apart. Each boat is 14-16 ft. long, 16 feet was used.  $5280 \times 8 = 42240$ ;  $42240 \div 64 = 660$  boats at one time. Practical maximum is 2/3 of 660 or 440 boats at one time.



The theoretical maximum for fishing is 352 PAOT. This is based on trout anglers requiring a 20 yd. radius Shelby and Heberlein (1988). Thus they required 120 feet of stream.  $5280 \times 8 = 42240$  feet.  $42240$  divided by 120 feet = 352 anglers. Practical maximum is  $2/3$  of that or 235 anglers.

The theoretical maximum for highway passenger vehicles is 2112 vehicles AOT. This is based on vehicles being 10 feet long and requiring 3 car length for safety.

Thus  $42240$  feet divided by 40 =  $1056 \times 2$  (both directions) = 2112.

Overall, physical carrying capacity is not a limiting factor since use does not even approach the physical space.

Facility Carrying Capacity: The theoretical maximum for developed sites is 199 PAOT (154 in CG units and 45 in PG units). Two-thirds of this is the practical maximum or 141 PAOT (114 in CG units and 27 in PG units).

The theoretical maximum for parking areas is 54 parties at one time. Practical maximum is  $2/3$  of that or 36 parties. Based on 19 pull-offs which can handle 60 cars - not all have enough good sites for camping.

Facilities are self limiting in that they can only accommodate up to five persons. Average occupancy is 88% on weekends and about 42% on weekdays. If additional picnic and campground units are constructed as stated in the Arapaho-Roosevelt Forest Plan, then facility is not the limiting factor.

Social Carrying Capacity: NOTE: Sampling of user preference was not carried out due to the limited time frame of the research project. For purposes of testing the model, estimates were made.

\* Estimates

After sampling boating users (clients of commercial outfitters, private users, outfitters), it was found that users prefer not to see more than 5-6 anglers (parties) per mile of river and not more than 5-8 parties of rafters or kayakers per mile. Outfitters want to preserve the recreation opportunity they are able to offer now and they also want to be able to launch at least 10 rafts per group in a half hour.

Additional sampling indicated that the amount of parking for anglers is about right. Anglers prefer not to have more than 3 other fishing parties within sight. Local users would like to see additional picnic sites along this section. Turning Young's Gulch into a combination picnic facility / trailhead is favored.

Table 1 displays a summary of the inventory information for the Mishawaka segment discussed above. The four types of Carrying Capacity are included under Carrying Capacity Factors. The current use levels are included for comparison. For all activities, except developed sites camping and picnicing, the current use is well below that of the physical or social parameters. Overnight dispersed use on weekends appears to be close to the

TABLE 1

ACTIVITY	CURRENT USE	CARRYING CAPACITY FACTORS				EXAMPLES OF PROCESS USING Using 8 miles Mishawaka Segment
		ECOLOGICAL	PHYSICAL	FACILITY	SOCIAL	POSSIBLE MANAGEMENT ACTIONS
Boating	Weekday/weekend 1/12 boats Launched per day	Trash, litter from picnicing.	Water space per boat - 660 watercraft at one time (82/ mile) <u>1</u> /	Put-in/ take-out facilities	# parties mile <u>3</u> /	Limit put in and take out facilities to 1 each per run. Regulate commercial users to no more than 8 launches per day. Require permits of private users.
Fishing	15 anglers/mile per day	Trash, litter entrails from anglers; tramp- ling of popular sites.	Water space per angler - 20 yd. radius. 352 PAOT (44/mile) <u>2</u> /	Roadside pull offs; Developed facilities	# anglers per mile	No action other than monitoring. Close waters to fishing. Require licenses lottery.
Developed Sites	88% of sites occupied on week- ends. 42% of sites occupied on weekday.	Frissell Class condition of sites; condi- tion of trees, vegetation.	Potential for 22 additional units	38 CG unit 14 PG unit	People per Unit. De- signed for 5 per unit.	Increase fees; Add 5 PG units-Mishawaka; change use at Upper Landing from CG to PG. Design entrance for better visibility; add 2 units at Poudre Park; build trailhead at Young's Gulch, 25 units, build 15 unit PG also.
Dispersed Recre- ation	Day use - 16 of 19 sites occu- pied. Overnight- 3 of 19 sites occupied. Week- day/weekend occu- pancy % 35/75.	Frissell Class condition of sites; trash, litter, water quality.	54 sites	Roadside pulloffs; Young's Gulch borrow pit area.	People/par- king space. Average of 3/parking space.	Close 2 areas to camping and parking where site rehabilitation is occurring.

1/ Safety requires 4 boat lengths apart.

2/ Shelly & Heberlein page 142.

3/ Party could be up to a group of 5 rafts.



practical maximum. The high weekend occupancy of developed sites may indicate the need for additional sites. Final decisions on construction of new facilities should be delayed until analysis of all segments is completed. In addition, consideration could be given to increasing use in under utilized facilities. The Possible Management Actions column suggests possible courses of action for limiting or changing activities if necessary.

Since the social aspect is the most limiting factor, Table 2 displays the preferred use levels under Social Factor (these are estimated, no actual sampling was done for this study) next to the current use. Again Table 2 shows that current use is well below that of theoretical and practical maximum values. However, as this example shows, the social standards may require that use levels be restricted in some cases. This is most clearly shown when all use information is expressed in PAOT. As pointed out earlier some information was either missing or inaccurate at the time of the study. The determination of the area carrying capacity is the sum of all the social capacities for each segment by recreation activity. The allocation is the sum of the ranges shown for each social carrying capacity. Therefore the current use and user preference sets the standard for this Roaded Natural corridor. If all the data used in this example was accurate and complete, then it appears that little action need be taken at this point. However, it should be noted that this conclusion might be different when the entire river corridor is considered. In addition, some restrictions on Outfitter and Guide use may need to be established for those providing boating opportunities to the public.

TABLE 2: EXAMPLE OF POSSIBLE RESULTS

## MISHAWAKA SEGMENT

CARRYING CAPACITY per 8 Miles

Activity	FOCUS ON SOCIAL FACTOR			
	THEORETICAL Maximum	PRACTICAL Maximum	USE LEVELS	SOCIAL Factor <u>1/</u>
Boating	660 Boats at one time	440 Boats at one time	# Launches weekday/weekend 1/12	5-8 parties/ mile 40-64 Boats at one time (320-512 PAOT) <u>2/</u>
Fishing	352 PAOT	235 PAOT	# Anglers/mile 15/mile/day	5-6 persons/ mile 40-48 PAOT
Developed Sites- Camping	154 PAOT	103 PAOT	% Occupancy weekday/weekend 42/88	95-110 PAOT
Developed Sites- Picnicing	45 PAOT	30 PAOT	% Occupancy weekday/weekend 45/90	Prefer Another P.G. 23-27 PAOT
Dispersed Use	54 parties 2.5 person/ party	36 parties	% Occupancy Weekday/weekend 30/75	25-30 Parties (63-75 PAOT)
Motorized Use	2112 Vehicles	1056 at one time (1/4 of theoretical)	560 vehicles per day	450-500 vehicles at one time. (1125-1250 PAOT) <u>3/</u>
TOTAL CARRYING CAPACITY			With motorized use 991-1272 PAOT	Without Motorized Use 541-772 PAOT

1/ Social factor is obtained from user preference sampling.2/ 8 persons per boat.3/ 2.5 persons per vehicle



## CHAPTER V

### SUMMARY AND CONCLUSIONS

Recreation carrying capacity has been written about and researched extensively over the last 10 years. Many papers fail to detail a methodology for determination and allocation of carrying capacity. Fewer still address the situation in question - a Roaded Natural Wild and Scenic River corridor. The focus of this research was to outline a procedure, test the model and produce a methodology for determination and allocation of a carrying capacity which would provide guidance to the Cache La Poudre Wild and Scenic River Management Area Analysis. This chapter will 1) summarize procedures and findings; 2) offer conclusions; 3) suggest implications and 4) make recommendations.

#### Summary of Procedures

The procedure developed is as follows:

1. Inventory and map the current situation.
2. Arrange the data in meaningful segments; describe primary emphasis of each.
3. Describe the four types of carrying capacity, both theoretical and practical maximum.
4. Determine the limiting factor or factors. If social, obtain user preference and manager preference information.
5. Determine and allocate the carrying capacity for each segment. Define the limits of acceptable change as a range for each recreation activity.
6. Describe monitoring procedures.

#### Findings are as follows

The human element, which is not directly correlated to type of recreation experience or amount of use, is often the limiting factor for carrying capacity in a Roaded Natural area. Therefore, sampling of user preference is strongly indicated for such situations. Some research findings on user preference suggest that often the current use is the preferred use. In some cases, even when users responded that they would prefer less crowding in river situations, they were not willing to change their behaviors if it meant limiting their use.

#### Conclusions -

The methodology developed and described in previous chapters is a sound method based on the literature findings, personal conversations with developers of the ROS system and river managers, experience and the testing of the model. There is no cookbook method or magic number for determination of carrying capacity. This paper suggests a workable procedure for determination and allocation in a Roaded Natural corridor. Having tested the model through determination and allocation, the author finds that the amount of time spent is not unreasonable - though it does involve more time than is usually spent on one area project. In

addition, the completion of overlays to display the information ties in with the Geographic Information (GIS) which will soon be available to most National Forest offices to aid in planning and analysis.

#### Discussion and Implications

When no social coefficients are given, it becomes incumbent on managers to set standards. Often these are based on what an experienced manager feels is "right" for the area. However this could clearly be viewed as biased by the public in a situation where a conflict exists. When there is potential for conflict or conflict exists, the standards need to be based on something other than gut feeling. User preference may appear somewhat arbitrary as a method for establishing a social standard. Realistically, this procedure provides a more consistent approach for managers to utilize when faced with establishing a social standard rather than relying solely on their intuition.

#### Recommendations

Requirements for completion of the process for the Cache La Poudre River Wild and Scenic River analysis include sampling of user preference, analysis of the user preference data and additional data Collection.

Since no models were found for sampling user preference which could be directly applied, developing a sampling procedure is the next and most crucial step. One such study which was conducted by Don Bruns of the Bureau of Land Management in Colorado may be helpful to review.<sup>1/</sup> A list of other researchers who may be contacted for additional information is included in Appendix B.

Suggestions for persons to sample are: outfitter - guide permittees, clients of these commercial outfitters, users of picnic and campgrounds, other users, residents, local users and anglers. The type of user preference information to collect: perceived crowding on the river (boating and fishing), how developed sites should be used (either Picnic or Camp sites), if certain uses conflict, what is the preferred trade-off?

Analysis of the user preference sampling will also need to be further researched using the same contacts. It is strongly recommended that an appropriate amount of thought be given to how the data will be analyzed BEFORE sampling begins so that it is collected properly. Because the Office of Management and Budget requires that survey questionnaires be cleared through their office before use, it is recommended that cooperation with a local university be secured.

The sampling results will be useful during public scoping efforts for the Wild and Scenic River Management Analysis, as well as for establishing the social standard. The user preference information can be presented to the public along with other data so that the consequences of various alternatives are more clearly displayed.

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<sup>1/</sup> Personal telephone conversation with Don Bruns in March 1988.



Additional items which were identified as missing data were: boating use, location of dispersed campsites, soil condition of developed and dispersed sites by Frissell Class, other dispersed use information and visual planning information for the entire corridor.

A final note is that while the carrying capacity for each segment can logically be calculated separately, before final recommendation, one should look at the big picture and see how the various alternatives affect the total spectrum of opportunities.

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## APPENDIX A

### DETAILS OF METHODOLOGY

The following is a more detailed look at the process and is included to indicate where difficulties are and to provide additional information in those areas. In order to provide a comprehensive picture of what's going on in the canyon, extensive interviews were conducted with seasonal and permanent employees who have worked in the canyon for the last several years, a Colorado Division of Wildlife (DOW) employee who has worked in the canyon for many years and a DOW researcher who is familiar with the area, Forest Service employees familiar with the boating situation, outfitters who have knowledge of boating activities, and Colorado State Highway Department for motorized use information. The author's personal experience was also included.

#### Step 1: Inventory and Map the Current Condition

This includes inventorying the recreational activities, the physical characteristics, the land ownership, and other jurisdictional limitations. The aim was to provide a visual picture of what is happening on the ground today. A decision was made to display the inventoried information on clear mylar overlays which could be used by placing them over the standard Forest Service Primary Base Series maps. The scale is the same as the USGS 1:24,000 topographic maps. Most Forest Service inventory information is already displayed using this scale. Overlays have been prepared for the following items:

- Recreation Sites
- Wildlife and Fishing activities
- Boating activities
- Visual Management information
- Land status
- Highway Department traffic volumes and roadside parking
- Archeological Sites

This is the point where management concerns and public issues about the area are tied into the methodology developed in this paper.

Recreation Sites include all existing Forest Service facilities for camping, picnicing etc.. Potential facilities shown in the Arapaho and Roosevelt National Forest Plan are also included.

Wildlife and Fisheries includes the sections of the Poudre river which are wild trout waters (unstocked), all other sections are stocked; popular fishing spots, areas of concentration of Bighorn sheep, and potential interpretative viewing areas. This information was obtained by interviewing the Col DOW Area District Manager, Howard Spear, who has worked in Poudre Canyon for 15 years. Discussions concerning hunting activities and big game populations revealed that these were not areas of concern in Poudre Canyon.

Boating Activities, which involves only day use, were mapped. They include the popular stretches of river typically run by commercial outfitters and private individuals both rafting and kayaking, all known locations where users put-in and take-out, extremely hazardous stretches, etc. This information was obtained from two sources: an interview with one of the outfitters, Pat Tierney, who has run the river for many years; Data collected by a seasonal in the summer of 1987 who observed and mapped put-in and take-out locations.

Visual Management includes an inventory of all aspects of the Visual Resource Management system such as Variety class, sensitivity level, visual quality objectives, distance zones. These were obtained from an inventory which was performed in 1976 and revised in 1979 and recorded on mylar overlays. These were confirmed on the ground in February 1988 and changes made where appropriate.

Land Status was displayed on overlays to highlight private landownership and indicate which were state lands, City of Fort Collins and other private ownership.

Highway Department information was displayed on overlays to show traffic volumes and roadside parking. This information was obtained from a 1980 Highway Department study which determined average daily traffic volumes at various points along the canyon. The 1980 figures were updated through a telephone conversation on February 3, 1988, with Bob Tenney, Colorado State Highway Department official. Also included on this overlay is an inventory of roadside parking spots which were not built nor are they maintained by the Forest Service. They are often used for fisherman parking, picnicing, camping and hunting. An estimate of the number of passenger vehicles which could fit in each pull-off was made. It is suggested that the amount of traffic moving through the canyon on any given day will not be a limiting factor, nor does there seem to be a need to limit the traffic.

Archeological Sites includes the prehistoric sites which were identified in an earlier Cultural Resources Inventory which was conducted during the development of the Wild and Scenic River EIS. About 50 sites were identified in the canyon.

Step 2: Arrange the data in appropriate subdivisions, describe the emphasis.

This was necessary to be able to discuss the current situation in meaningful terms. There is precedent for doing this. The Cache La Poudre Wild and Scenic River EIS divided the river into segments for the same reason. In addition the research paper on establishing a carrying capacity for the Indian Peaks Wilderness area (Smith 1983) also used the method of dividing the study area into meaningful subdivisions. Describing each segment gives the various segments a focus. The emphasis was suggested from the information collected during inventory and mapping. Missing data is also identified.



Step 3: Describe the four types of carrying capacity including the theoretical and practical maximum.

This was approached in the following manner: ecological carrying capacity has standards and guidelines in the Forest Plan. This aspect was not dealt with in this paper except for using hypothetical information when testing the model. Physical carrying capacity is a matter of how much space is available for various activities. Physical carrying capacity was inventoried for the purposes of this research paper and included information on potential camping, picnicing, put-in and take-out facilities. The facility carrying capacity was also inventoried and mapped on overlays. This included all existing developed facilities. The social carrying capacity as mentioned earlier does not have any set standards and guidelines. Available studies on river use indicate that user satisfaction and perceived crowding is highly variable and very dependent on user preference. Step 3 also included the determination of the theoretical maximum and the practical maximum. This was accomplished by utilizing existing use information when available and estimates where accurate data was not available.

Step 4: Determine the limiting factor or factors.

The current use for each type of activity becomes the basis for determining the carrying capacity and defining the limits of acceptable change. Since user preference information was not available, hypothetical information was used.

## APPENDIX B

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